

## *Nucella megastoma*, A New Late Pliocene Muricid Gastropod from Northern California

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***Nucella megastoma* new species from the Merced Formation of San Mateo County and the Wilson Grove Formation of Sonoma County, both late Pliocene of California, is distinguished by the presence of a labral tooth, strong alternating spiral cords, and a large aperture. This rocky-shore predatory muricid gastropod co-occurred with several other muricids, including four species of *Nucella* without a labral tooth and a labral-tooth-bearing species of *Acanthinucella*.**

*Nucella* is a species-rich genus of northern-hemisphere ocenebrine muricid gastropods with a relatively well-documented history dating back to the late Oligocene (Collins et al. 1996; Marko and Vermeij 1999; Vermeij 2001). Species-level taxonomy based on shell characters is problematic in this group owing to the great variation — much of it the result of phenotypic plasticity — in such features as the number and expression of spiral cords, thickness of the outer lip, expression of denticles on the inner side of the outer lip, spire height, and length of the siphonal canal. It is therefore with considerable surprise that a hitherto undescribed species of this genus should come to light. Although only two specimens of this new form are available, they are so distinctive that the formal proposal of a new species for them is warranted. Here we describe it as *Nucella megastoma* sp. nov.

### GEOLOGICAL SETTING

The new species comes from the Merced Formation of San Mateo County and the Wilson Grove Formation of Sonoma County, both in north-central coastal California. The Merced Formation ranges in age through much of the Pliocene and Pleistocene (Ingram and Ingle 1998). Its molluscan fauna (Glen 1959; Yancey 1978) contains several intertidal muricids, including *Acanthinucella spirata* (de Blainville 1832), *Nucella analoga* (Forbes 1950) (see below), *N. emarginata* (Deshayes 1839) in the broad sense, and *N. lamellosa* (Gmelin 1791); but our new species *N. megastoma* was not previously reported as part of this fauna. [Glen also reports *N. lima* (Martyn) and *Ocenebrina interfossa* (Carpenter) from the “Merced” Formation at Pillar Point, but Powell (1998) following Wiley (1983) and Wiley and Moore (1983) refer the outcrops at Pillar Point to the Purisima Formation.] The Wilson Grove Formation is of late Miocene to late Pliocene age (Powell et al. 2003), but the locality from which we report *N. megastoma* was determined on paleontological grounds to be of late Pliocene age (Powell et al. 2003). At this locality, the new species (reported by Powell et al. 2003, as *Acanthinucella* sp.) co-occurs with *Nucella trancosana* (Arnold 1908). These and several other rocky-shore gastropods are found alongside other molluscs that are

inferred to have lived at shelf depth offshore (Powell et al. 2003). It is likely that *N. megastoma* lived in an exposed rocky-shore setting, where species are not normally preserved as fossils. Fossilization of such rocky-shore species depends on transport to environments where sedimentation permits fossil preservation.

## SYSTEMATICS

### Family Muricidae Rafinesque, 1915

### Subfamily Ocenebrinae Cossmann, 1903

### Genus *Nucella* Röding, 1798

TYPE SPECIES: *N. lapillus* (Linnaeus, 1758) (see Kool and Boss 1992)

### *Nucella megastoma* Vermeij and Powell, sp. nov.

(Figs. 1a–d)

*Acanthinucella* sp., Powell et al. 2003, Table 11.

**DIAGNOSIS.**— Medium-sized *Nucella* with low spire, rounded last whorl, high alternating spiral cords, a broad aperture, thin outer lip without denticles on inner side, and strong labral denticle at apertural end of external spiral groove located above basalmost spiral cord.

**DESCRIPTION OF HOLOTYPE.**— Shell medium-sized, height 26.8 mm (apex broken off), spire low (aperture height:shell height ratio 0.85); preserved teleoconch consisting of three whorls, of which the last one is large, rounded, and inflated, without shoulder angulation and without basal constriction on right (outer-lip) side; axial sculpture absent except for growth increments; spiral sculpture of last whorl consisting of nine high, sharply rounded, primary cords; adjacent cords separated by distinct secondary cord; a secondary cord also present between suture and first primary cord; widest point of shell located at fourth cord from suture; aperture wide, its height:width ratio 2.1; outer lip thin, its inner side without denticles; anterior of outer lip with distinct labral tooth formed at apertural end of external spiral groove situated between the two most basal primary cords; columella rounded, smooth, without parietal tooth at adapical end; umbilical slit absent; siphonal fasciole high, sharply rounded.

**HOLOTYPE:** CAS Geology 69251: height (incomplete) 26.8 mm, diameter 23.3 mm, aperture height 22.0 mm, aperture width 10.8 mm, outer-lip thickness 1.0 mm.

**TYPE LOCALITY:** Seven Mile Beach, San Mateo County, California, Merced Formation (late Pliocene).

**DESCRIPTION OF PARATYPE.**— Shell height 37.4 mm (incomplete); similar to holotype except that the spiral sculpture on the last whorl consists of seven primary cords, which have no secondary cord between them except on the abapertural side.

**PARATYPE:** CAS Geology 69252: height 37.4 mm, diameter 33.7 mm, aperture height 28.0 mm, aperture width 14.0 mm, outer-lip thickness 1.6 mm.

**LOCALITY OF PARATYPE:** north side of River Road, 0.2 miles north of Trenton, 0.3 miles east of intersection of River Road and Trenton-Healdsburg Road, Sonoma County, California; Wilson Groove Formation (late Pliocene).

**REMARKS.**— Although the two available specimens differ somewhat in sculpture, notably in the expression of secondary cords, they share the presence of a labral tooth, a broad aperture, a basally constricted whorl on the apertural side of the last whorl, and seven to nine strong primary cords alternating with secondary cords. These distinctive features indicate a single species-level taxon in the genus *Nucella*.

Living intertidal ocenebrine muricids with a labral tooth in the northeastern Pacific mostly belong to the genera *Acanthinucella* Cooke, 1918, and *Mexacanthina* Marko and Vermeij, 1999. These genera differ from *Nucella megastoma* by generally having a shoulder angulation and by the usual presence of deeply recessed denticles on the inner side of the outer lip. In *Mexacanthina*, moreover, the conspicuous labral tooth has a more basal position than in *N. megastoma*, in which the tooth is situated above the lowest cord instead of below the lowest cord. In *Acanthinucella*, several spiral cords are situated below the tooth-bearing groove (see Marko and Vermeij 1999; Vermeij 2001). Data from mitochondrial gene sequences show that *Acanthinucella*, which appears in California during the "Margaritan" stage of the late Miocene as *A. norma* (Nomland 1917), is part of a South American clade (Marko and Vermeij 1999) dating back to the late Oligocene (Vermeij 2001; DeVries and Frassinetti 2003). *Mexacanthina* is a Pleistocene to Recent genus whose labral tooth is inferred to have evolved independently from that in either *Acanthinucella* or *Nucella* (Marko and Vermeij 1999). *Nucella*, a late Oligocene to Recent genus with origins in the northeastern Pacific (Amano et al. 1993), consists mainly of species without a labral tooth, but *N. packi* (Clark 1918) from the late Oligocene of California and some specimens of *N. analoga compressa* (Dall 1915) have a labral tooth (Vermeij 2001).

*Nucella megastoma* is best compared to three Recent species of the genus from the northeastern Pacific. *Nucella lima* (Gmelin 1791), a common species in Alaska, is like *N. megastoma* in having a low spire, alternating spiral cords, and a broad aperture with a thin outer lip. There are typically nine or ten primary cords, but a labral tooth of the type seen in *N. megastoma* is never present. *N. canaliculata* (Duclos 1932), another common northern species, has nine to 11 high spiral cords and much smaller secondary cords. Its aperture is more elongate than that of *N. lima* and *N. megastoma*, and a labral tooth is rarely present. In a few specimens in the Vermeij collection from Attu (Aleutian Islands, Alaska), a barely perceptible labral tooth is situated at the apertural end of a spiral groove between the two most basal primary cords. J. H. McLean (pers. commun. to Vermeij, July 2003) distinguishes between a northern *N. canaliculata* and the more southerly *N. analoga* (Forbes 1850), which ranges from Vancouver Island (British Columbia) to central California. Vermeij's examination of specimens confirms McLean's interpretation. *N. analoga* has 16 to 18 low, somewhat flat-topped cords, usually without secondaries, on the last whorl. A labral tooth is absent. In populations from central California, which Dall (1915) named as the form *compressa*, one or more of the abapical crenations on the outer lip is enlarged to form a labral tooth. This form has 11 to 13 cords without secondaries on the last whorl, and is in Vermeij's view distinct from typical *N. analoga*. All these taxa — *N. canaliculata*, *N. analoga*, and the form *compressa* — which were formerly regarded as belonging to the single taxon *N. canaliculata*, differ from *N. megastoma* by being slightly basally constricted and by having a higher spire.

At its type locality (Seven Mile Beach, San Mateo County, in the Merced Formation), *N. megastoma* co-occurs with *N. analoga*. The available specimens of *N. analoga* from this locality and from other localities in the Merced Formation lack a labral tooth and are indistinguishable from Recent examples (Fig. 1, e–f).

Three fossil species of *Nucella* resemble *N. megastoma*. The most similar fossil species to *N. megastoma* is *N. packi* (Clark 1918) from the San Ramon Sandstone (late Oligocene) of Contra Costa County, California. This species is thick-shelled and low-spired, and has 15 low cords without secondaries, as well as traces of a labral tooth at the apertural end of an external groove between the two most basal cords (Amano et al. 1993; for assignment to *Nucella* see Marko and Vermeij 1999; Vermeij 2001). *N. packi* differs from *N. megastoma* by having a slightly constricted base, more numerous and lower spiral cords, and by having denticles deeply recessed on the inner side of the outer lip. The early to middle Miocene *N. tokudai* (Yokoyama 1932), known in California



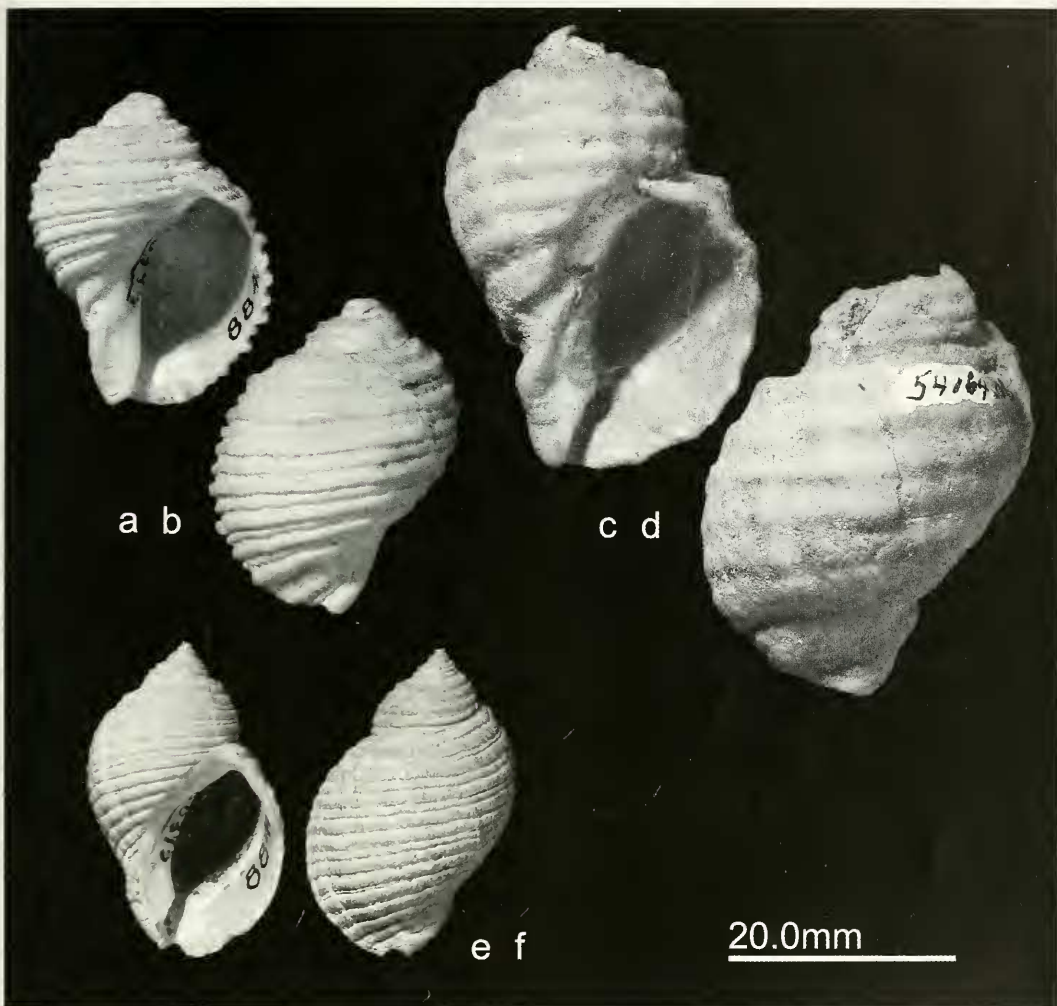


FIGURE 1. a–b, *Nucella megastoma*, sp. nov., holotype, Merced Formation. c–d, *Nucella megastoma* sp. nov., paratype, Wilson Grove Formation. e–f, *Nucella analoga* (Forbes, 1850), Merced Formation at Seven Mile Beach, San Mateo County, California.

also as *Thais* (*Stramonita*) *carrizoensis* Loel and Corey 1932, is a low-spired species that differs from *N. megastoma* by having more numerous primary cords (11 to 19 versus seven to nine), having denticles inside the outer lip, and lacking a labral tooth (see Amano et al. 1993 for detailed discussion of this species and its relation to *N. packi*, with which *T. (S.) carrizoensis* had been synonymized by Addicott 1970). Finally, the Pliocene *N. trancosana* (Arnold 1908) is characterized by a very thick shell, 13 or more very low (often obsolete) spiral cords, and denticles on the inner side of the outer lip. A labral tooth is absent (see also Addicott 1969). *N. trancosana* is not known from the Merced Formation (Glen 1959; Yancey 1978) but does co-occur with *N. megastoma* in the Wilson Grove (Powell et al. 2003) Formation.

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